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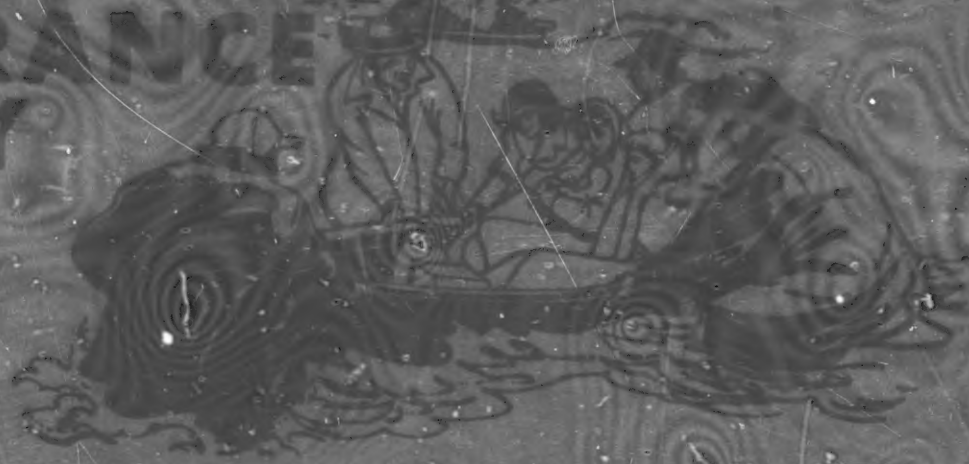

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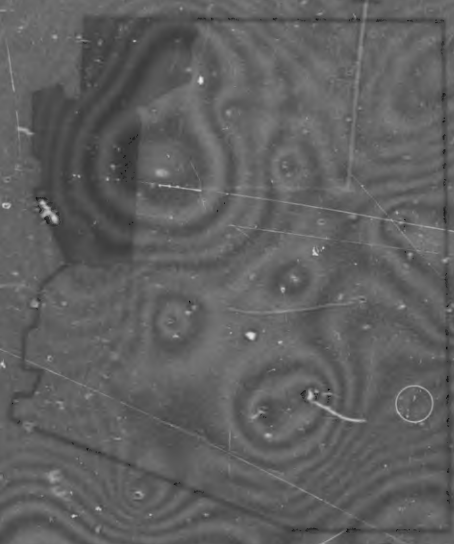

CITY OF BULLHEAD CITY, ARIZONA
MOHAVE COUNTY

AUGUST 5, 1986

Federal Emergency Management Agency

COMMUNITY NUMBER - 040128

FOR FLOOD INSURANCE

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1.0 INTRODUCTION

1.1 Purpose of Study

This Flood Insurance Study investigates the existence and severity of flood hazards in the City of Bullhead City, Mohave County, Arizona, and aids in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. This study will be used to convert the City of Bullhead City to the regular program of flood insurance by the Federal Emergency Management Agency (FEMA). Local and regional planners will use this study in their efforts to promote sound flood plain management.

This Flood Insurance Study was prepared by compiling existing hydrologic and hydraulic technical and scientific data. The data were identified as the best available at the time of compilation of this Flood Insurance Study and should depict the general conditions of the flooding sources with relative accuracy. FEMA performed a cursory review and accepted the data as valid for purposes of this Flood Insurance Study and the National Flood Insurance Program (NFIP). However, if better information is known to exist or has been developed since the date of this study, the information should be immediately forwarded to the address below for consideration for revision of this study.

> Natural and Technological Hazards Division, FEMA, Building 105, Presidio of San Francisco, San Francisco, California 94129

In some states or communities, flood plain management criteria or regulations may exist that are more restrictive or comprehensive than those on which this federally supported study is based. These criteria take precedence over the minimum Federal criteria for purposes of regulating development in the flood plain, as set forth in the Code of Federal Regulations at 44 CFR 60.3(c). In such cases, however, it shall be understood that the State (or other jurisdictional agency) shall be able to explain these requirements and criteria.

1.2 Authority and Acknowledgments

The sources of authority for this Flood Insurance Study are the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973.

The hydrologic and hydraulic analyses for this study were performed by Henningson, Durham and Richardson, Inc., of Arizona, as reported

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in the Flood Insurance Study for the unincorporated areas of Mohave County, Arizona (Reference 1).

1.3 Coordination

On April 11, 1985, Dames & Moore was instructed by FEMA to proceed with an existing data study for the City of Bullhead City using data from the Mohave County Flood Insurance Study (Reference 1).

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated areas of the City of Bullhead City, Mohave County, Arizona. The area of study is shown on the Vicinity Map (Figure 1).

Approximate analyses were used to study those areas having a low development potential or minimal flood hazards. The scope and methods of study were proposed to, and agreed upon by, FEMA and the City of Bullhead City.

The following flooding sources in the North Mohave Valley area (from Katherine Landing to Big Bend) were studied by detailed methods:

Davis Wash, for approximately 2.1 miles upstream of its confluence with the Colorado River

Highland-Williams Wash, for approximately 4.4 miles upstream of its confluence with the Colorado River

Highland-Green Wash, for approximately 4.1 miles upstream of its confluence with the Colorado River

Thumb Butte Wash, for approximately 3.0 miles upstream of its confluence with the Colorado River

Buck Wash, for approximately 2.2 miles upstream of its confluence with the Colorado River

Black Wash, for approximately 2.3 miles upstream of its confluence with the Colorado River

Bullhead Wash, for approximately 1.2 miles upstream of its confluence with the Colorado River

Secret Pass Wash, for approximately 2.1 miles upstream of its confluence with the Colorado River

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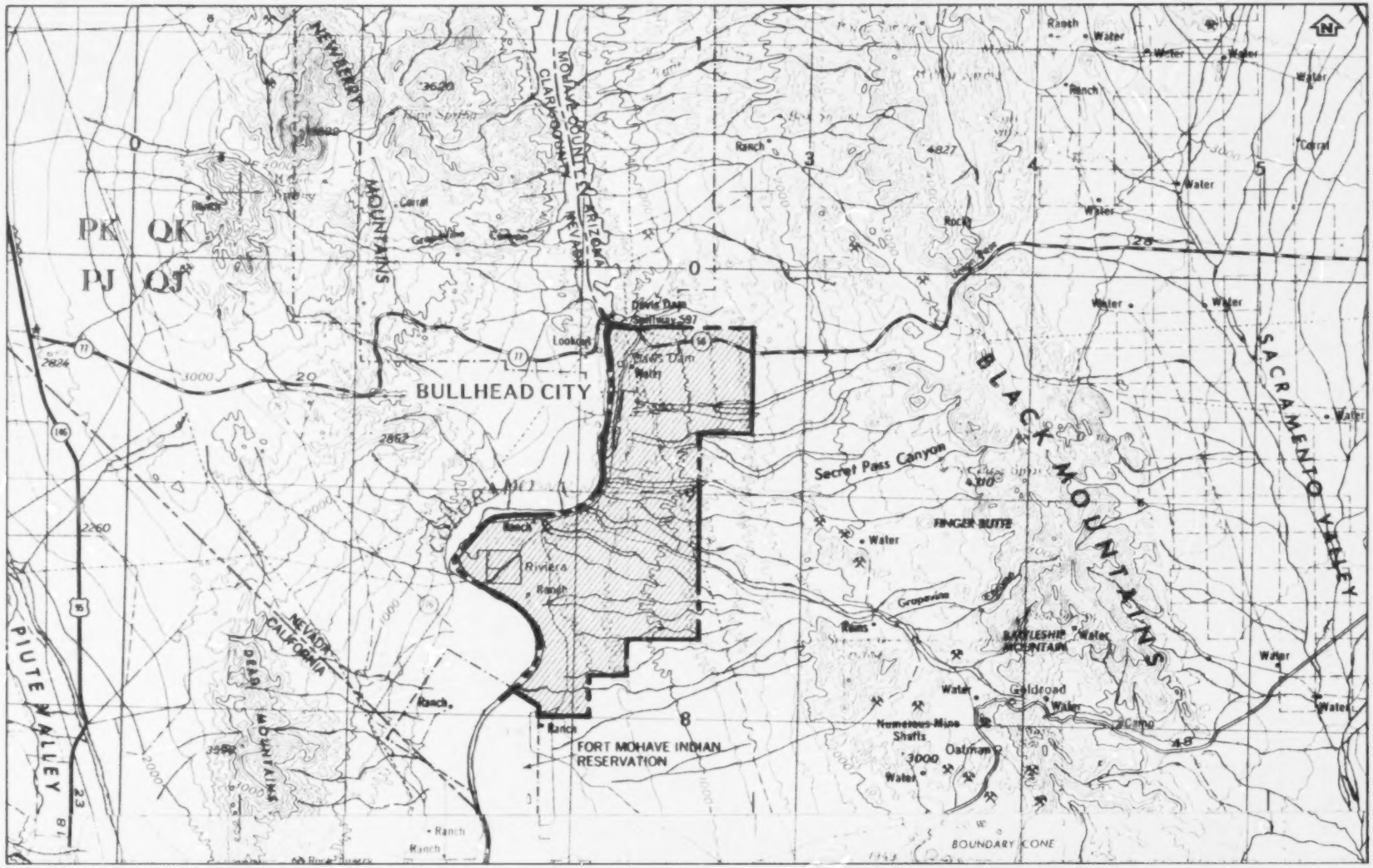

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY

CITY OF BULLHEAD CITY, AZ
(MOHAVE CO.)

APPROXIMATE SCALE
4 0 4 8 12 MILES

VICINITY MAP

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Dump Wash, for approximately 1.3 miles upstream of the Colorado River

Silver Creek Wash, for approximately 3.4 miles upstream of the Colorado River

Montana Wash, for approximately 3.7 miles upstream of its confluence with the Colorado River

Big Montana Wash, for approximately 3.3 miles upstream of its confluence with the Colorado River

Chapparal Wash, from its confluence with Bojcrquez Wash to State Highway 95

Bojorquez-Fox Wash, for approximately 2.8 miles upstream of its confluence with the Colorado River

Soto Wash, for approximately 2.3 miles upstream of its confluence with the Colorado River

Fort Mohave Wash, for approximately 2.7 miles upstream from its confluence with the Colorado River

The areas studied by detailed methods were selected with priority given to all known flood hazard areas and areas of projected development or proposed construction through 1989.

2.2 Community Description

The City of Bullhead City lies in the North Mohave Valley, along the Colorado River, in west-central Mohave County, in northwestern Arizona. The climate in this area is extremely arid, and the mean annual maximum temperature is 85.4°F. The recorded extreme temperatures are 121°F and 20°F. The mean annual precipitation is 4.2 inches along the Colorado River and is an estimated 8 inches in the Black Mountains (Reference 2).

Elevations through the Bullhead City area range from 500 to 540 feet. To the east, the Black Mountain Range rises to an elevation of 5,062 feet at Mount Nutt.

Extremely gravelly Carrizo soil makes up the recent alluvial fans originating in the mountains. These fans have been channelized in the northern valley by hills with a Pinamt-Gunsight soil complex. An aerial view of Bullhead City is shown in Figure 2. Potential scouring depths are in excess of 5 feet. The average slope in the northern valley is over 4 percent; in the southern valley, it is approximately 3 percent.

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Figure 2. Aerial View, Bullhead City, Arizona

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The natural vegetation along the Colorado River includes mesquite, tamarisk, arroweed, and saltgrass. The desert grasses include galleta and three-awns along with other annuals. Creosote bush, bursage, paloverde, and catclaw comprise the desert shrubs. In the foothills, such cacti as cholla, ocotillo, saguaro, and prickly pear are common (Reference 3).

Residential and commercial development has been extensive at the lower elevations in the alluvial fans and along the Colorado River.

2.3 Principal Flood Problems

For the Bullhead City area, the independent alluvial fan washes originating in the higher elevations of the Black Mountains and mesas are the most hazardous source of flooding. Floodwaters are not the only cause of destruction. Scour, erosion, and alluvium deposition have caused catastrophic damage since the development of this area.

The many levees and dikes found in the washes offer no flood protection. Consisting of extremely gravelly sand with no reinforcement or bonding material, these dikes and levees are highly vulnerable to erosion and are easily washed away at any location. Consequently, they provide little or no protection against major flooding.

Historically, major floods occur in July, August, and September, when tropical depressions move up the Colorado River valley. More recently, tropical storms Kathleen on September 10-11, 1976 (Figures 3 through 6), and Doreen on August 16, 1977 (Figures 7 through 10), caused millions of dollars worth of property damage.

2.4 Flood Protection Measures

No major flood protection structures are located within the study area.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Flood events of a magnitude which are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) have been selected as having special significance for flood plain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10, 2, 1, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. Although the recurrence interval represents the long-term average period between floods of a specific magnitude, rare floods could occur at short intervals or even

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Figure 3. Chaparral Washington Area Just West of State Highway 95 (Photograph Courtsey of Mohave Valley News)

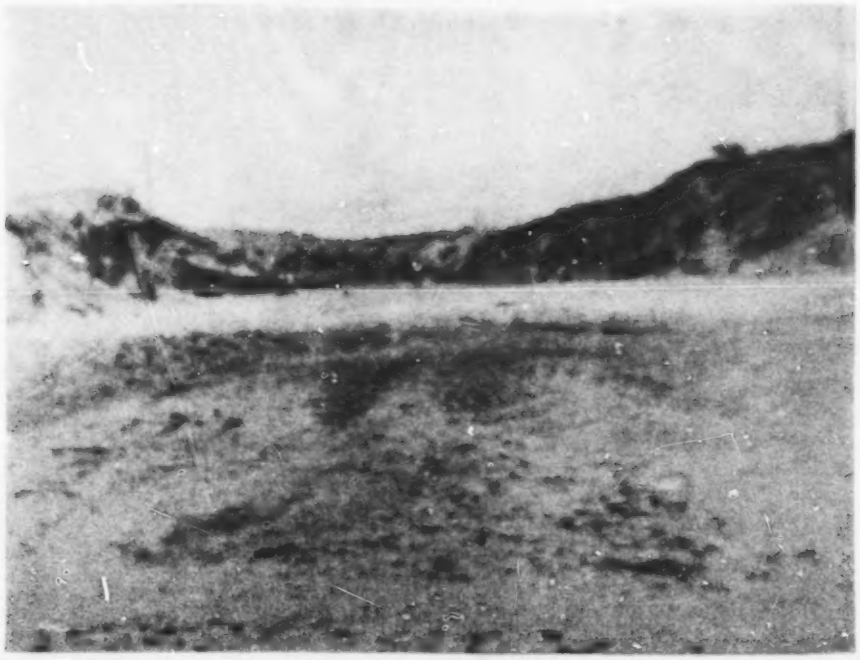

Figure 4. Chaparral Wash, Once an 8-Foot Ditch, Now 25-Foot-High Walls (Photograph Courtsey of Mohave Valley News)

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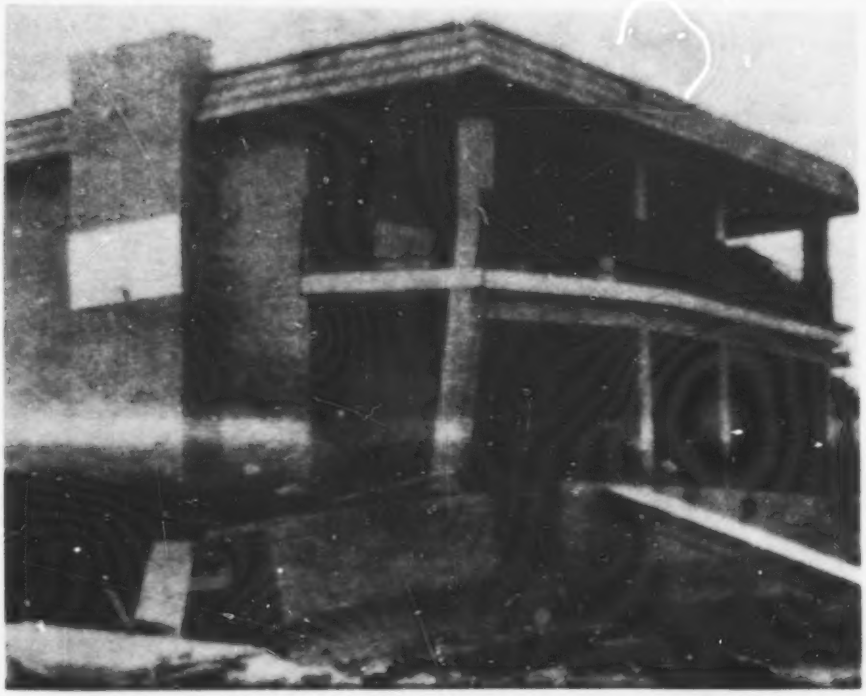

Figure 5. Structural Damage From Undermining Floodwaters Near Montana Wash at Colorado River (Photograph Courtsey of Mohave Valley News)

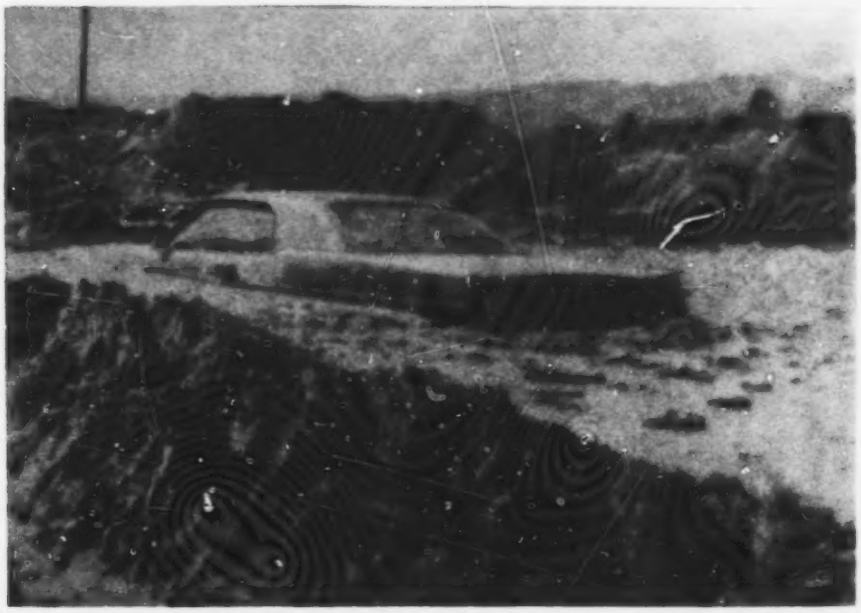

Figure 6. Alluvium Deposit Near Montana Wash (Photograph Courtsey of Mohave Valley News)

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Figure 7. Remains of Seventh Street in Bullhead City Looking West (Photograph Courtsey of Mohave Valley News)

Figure 8. Floodwaters Recede Near Secret Pass Wash Crossing Over State Highway 95 (Photograph Courtsey of Mohave Valley News)

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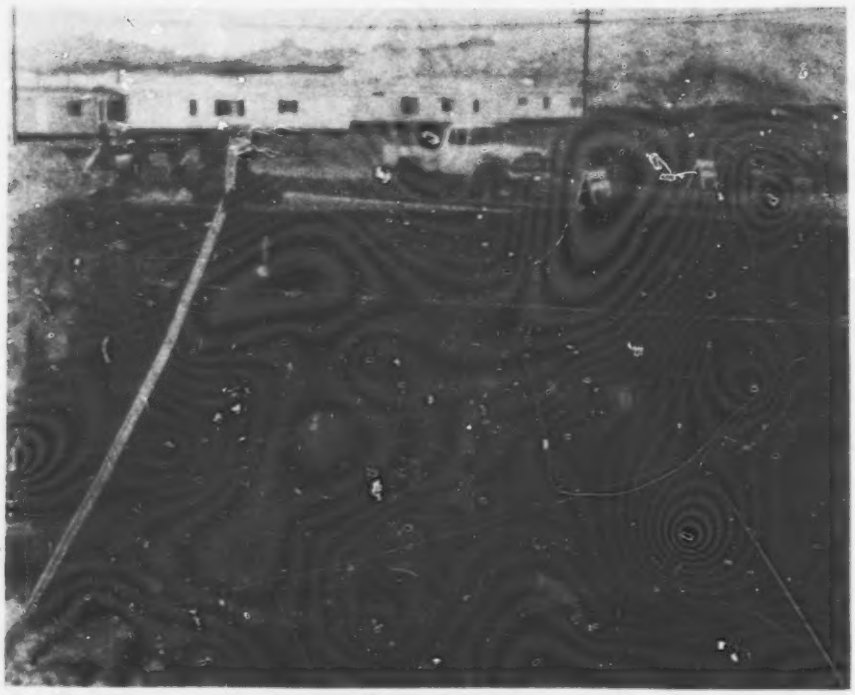

Figure 9. Silver Creek Wash Scouring Damage at State Highway 95 (Photograph Courtsey of Mohave Valley News)

Figure 10. Floodwaters Undermine and Devastate Foundations in Black Wash (Photograph Courtsey of Mohave Valley News)

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within the same year. The risk of experiencing a rare flood increases when periods greater than 1 year are considered. For example, the risk of having a flood which equals or exceeds the 100-year flood (1 percent chance of annual exceedence) in any 50-year period is approximately 40 percent (4 in 10), and, for any 90-year period, the risk increases to approximately 60 percent (6 in 10). The analyses reported herein reflect flooding potentials based on conditions existing in the community at the time of completion of this study. Maps and flood elevations will be amended periodically to reflect future changes.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for each flooding source studied in detail affecting the community.

Discharges for the flooding sources studied in detail were developed using Computer Program for Project Formulation, Hydrology (Reference 4). This U.S. Soil Conservation Service methodology uses basin physical characteristics, soil classification, cover conditions, and precipitation amounts as parameters for developing runoff.

Each basin was divided into subwatersheds with attention given to homogeneity, soil type, and cover conditions. Times of concentration were computed using Manning's equation to develop the velocity component. Drainage areas were measured using U.S. Geological Survey topographic maps (Reference 5).

Soil classification and cover conditions were determined from field surveys; General Soil Map and Interpretations, Mohave County, Arizona (Reference 6); and an unpublished soil survey for parts of Mohave County obtained through the U.S. Soil Conservation Service, Kingman Field Office. Antecedent moisture condition 2 was used for the soil moisture content.

A National Oceanic and Atmospheric Administration precipitation-frequency atlas (Reference 7) was used to select rainfall amounts for the 10-, 50-, and 100-year events. The 500-year rainfall amount was derived on extreme probability paper from extrapolation of a line through the plotted 10-, 50-, and 100-year values.

All flooding sources were analyzed to determine the peak discharge for the 1- and 24-hour rainfall distributions.

Peak discharge-drainage area relationships for the flooding sources studied in detail are shown in Table 1.

Discharges on Secret Pass Wash decrease toward the downstream end of the study area because of absorption by the ground alluvium, the narrowing of the drainage basin near State Highway 95, and the lack of tributary drainage.

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Table 1. Summary of Discharges

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (Cubic Feet per Second) 10-Year	50-Year	100-Year	500-Year
Davis Wash					
At Upstream Limit of Detailed Study	1.3	545	1,050	1,310	1,900
At State Highway 95	1.7	595	1,190	1,500	2,320
Highland Wash					
At Confluence with Green and Williams Washes	5.0	1,020	2,625	3,285	5,540
At State Highway 95	5.4	1,025	2,660	3,330	5,655
Williams Wash					
At Upstream Limit of Detailed Study	1.4	470	1,135	1,400	2,135
At Confluence With Highland Wash	2.8	605	1,555	1,930	3,225
Green Wash					
At Upstream Limit of Detailed Study	0.8	265	600	750	1,140
At Confluence With Highland Wash	2.2	440	1,155	1,460	2,410
Thumb Butte Wash					
At Upstream Limit of Detailed Study	2.0	550	1,245	1,565	2,350
At State Highway 95	7.3	1,685	4,100	5,020	8,085
Buck Wash					
At Upstream Limit of Detailed Study	0.5	155	330	420	625
At State Highway 95[1]	1.0	380	907	1,145	1,875
Black Wash					
At Upstream Limit of Detailed Study	14.4	3,265	8,250	10,200	16,035
At State Highway 95	15.0	2,570	6,670	8,205	13,760

[1] 20 Percent of Discharge Diverted to Bullhead Wash

Table 1. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (Cubic Feet per Second) 10-Year	50-Year	100-Year	500-Year
Bullhead Wash					
At Upstream Limit of Detailed Study	1.2	420	1,010	1,285	1,975
At State Highway 95	1.5	920	2,315	2,980	4,700
Secret Pass Wash					
At Upstream Limit of Detailed Study	20.3	4,345	9,860	12,085	18,105
At State Highway 95	21.1	4,280	9,750	11,955	18,325
Dump Wash					
At Upstream Limit of Detailed Study	2.4	520	1,365	1,745	2,910
At State Highway 95	3.0	610	1,610	2,060	3,450
Silver Creek Wash					
At Upstream Limit of Detailed Study	28.8	5,420	11,975	14,715	22,715
At State Highway 95	35.7	5,725	12,655	15,565	24,050
Montana Wash					
At Upstream Limit of Detailed Study	2.4	525	1,355	1,725	2,765
At State Highway 95	4.3	685	1,900	2,435	4,220
At Confluence With Colorado River	6.0	1,035	2,775	3,540	5,970
Big Montana Wash					
At Upstream Limit of Detailed Study	0.7	285	545	690	990
At State Highway 95	1.3	370	845	1,065	1,620
At Confluence With Montana Wash	1.7	405	910	1,155	1,805
Chaparral Wash					
At State Highway 95	1.9	475	1,060	1,320	2,000

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Table 1. Summary of Discharges (Cont'd)

Flooding Source and Location	Drainage Area (Square Miles)	Peak Discharges (Cubic Feet per Second) 10-Year	50-Year	100-Year	500-Year
Bojorquez Wash					
At Lause Road	5.4	825	2,285	2,920	4,795
At Lakeside Drive	11.1	1,470	4,580	5,870	9,805
Fox Wash					
At Upstream Limit of Detailed Study	3.2	595	1,545	1,960	3,170
Soto Wash					
At Upstream Limit of Detailed Study	2.2	540	1,420	1,780	2,725
At State Highway 95	2.7	550	1,460	1,840	2,940
Fort Mohave Wash					
At Upstream Limit of Detailed Study	4.7	985	2,540	3,190	4,975

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of flooding from the sources studied were carried out to provide estimates of the elevations of floods of the selected recurrence intervals.

For the Bullhead City area, statistical analyses were used to compute flood depths and velocities for the areas subject to alluvial fan flooding. In accordance with FEMA guidelines, the alluvial fan is characterized by unstable channel systems due to slope and soil conditions. Consequently, flows rarely spread evenly over the surface of an alluvial fan and can be concentrated in an identifiable, temporary channel or confined to only portions of the fan surface. The ability to scour and deposit sediment makes flow paths prone to lateral migration and relocation to any portion of the fan during a single runoff event and subsequent events. This erratic, unpredictable behavior subjects all portions of the fan to potential flood hazard, regardless of location. As the fan widens, the probability of flooding at a given depth and velocity at a specific point generally decreases.

In the low-lying area of Chaparral Golf Course in North Mohave Valley, Bojorquez Wash causes ponding. Runoff runs to the north and is discharged through a storm drainage channel into the Colorado River. A reservoir flood-routing method was used to model the area and determine the base flood elevation.

Normal-depth calculations supplemented the alluvial fan methodology on the upstream reaches of Highland, Williams, and Big Montana Washes.

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD). Elevation reference marks used in this study are shown on the maps; the descriptions of the marks are presented in Elevation Reference Marks (Exhibit 2).

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

The NFIP encourages State and local governments to adopt sound flood plain management programs. Therefore, each Flood Insurance Study provides 100-year flood elevations and delineations of the 100- and 500-year flood plain boundaries and 100-year floodway to assist communities in developing flood plain management measures.

4.1 Flood Boundaries

To provide a national standard without regional discrimination, the 1 percent annual chance (100-year) flood has been adopted by FEMA as the base flood for flood plain management purposes. The 0.2 percent annual chance (500-year) flood is employed to indicate

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additional areas of flood risk in the community. For each stream studied in detail, flood plain boundaries for the alluvial fans and shallow flooding were delineated on topographic maps at a scale of 1:24,000, reduced to a scale of 1:4,800, with a contour interval of 40 feet (Reference 5).

Approximate flood plain boundaries in some portions of the study area were taken from the Flood Hazard Boundary Map for Mohave County (Reference 8) and verified using the topographic maps previously referenced and reduced to a scale of 1:4,800 in conjunction with previously estimated elevations.

Flood plain boundaries are indicated on the Flood Insurance Rate Map (Exhibit 1). On this map, the 100-year flood plain boundary corresponds to the boundary of the areas of special flood hazards (Zones A, AH, and AO); and the 500-year flood plain boundary corresponds to the boundary of areas of moderate flood hazards.

4.2 Floodways

The floodway is the channel of a stream, plus any adjacent flood plain areas, that must be kept free of encroachment so that the 100-year flood can be carried without substantial increases in flood heights.

In the case of shallow and alluvial fan flooding, the unpredictable flow paths make delineation of a floodway meeting FEMA criteria impossible. However, the community should regulate development in swales due to the higher risk of shallow flooding in these areas as seen from historical flood damage.

5.0 INSURANCE APPLICATION

For flood insurance rating purposes, flood insurance zone designations are assigned to a community based on the results of the engineering analyses. These zones are as follows:

Zone A

Zone A is the flood insurance rate zone that corresponds to the 100-year flood plains that are determined in the Flood Insurance Study by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no base flood elevations or depths are shown within this zone.

Zone AH

Zone AH is the flood insurance rate zone that corresponds to the areas of 100-year shallow flooding where average depths are between 1 and 3 feet (usually areas of ponding). Whole-foot base flood

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elevations derived from the detailed hydraulic analyses are shown at selected intervals within this zone.

Zone A0

Zone A0 is the flood insurance rate zone that corresponds to the areas of 100-year shallow flooding where average depths are between 1 and 3 feet (usually sheetflow on sloping terrain). Average whole-foot depths derived from the detailed hydraulic analyses are shown within this zone.

Zone X

Zone X is the flood insurance rate zone that corresponds to areas outside the 500-year flood plain, areas within the 500-year flood plain, areas of 100-year flooding where average depths are less than 1 foot, areas of 100-year flooding where the contributing drainage area is less than 1 square mile, and areas protected from the 100-year flood by levees. No base flood elevations or depths are shown within this zone.

Alluvial fan flood hazard areas are shown on the Flood Insurance Rate Map as Zone A0, with average depths and velocities of flow given. In these areas, the 100-year flood depths may exceed 3 feet. Development on alluvial fans is subject to a more severe flood hazard than would normally be encountered in Zone A0 because of high velocities and the unpredictability of the location of the stream channel across the width of the fan.

6.0 FLOOD INSURANCE RATE MAP

The Flood Insurance Rate Map is designed for flood insurance and flood plain management applications.

For flood insurance applications, the map designates flood insurance rate zones as described in Section 5.0 and, in the 100-year flood plains that were studied by detailed methods, shows selected whole-foot base flood elevations or average depths. Insurance agents use the zones and base flood elevations in conjunction with information on structures and their contents to assign premium rates for flood insurance policies.

For flood plain management applications, the map shows by tints, screens, and symbols the 100- and 500-year flood plains, the floodways, and the locations of selected cross sections used in the hydraulic analyses and floodway computations.

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7.0 OTHER STUDIES

Because this study has been prepared using the Flood Insurance Study for Mohave County (Reference 1), the results of this study will match exactly the results of the Mohave County study.

8.0 LOCATION OF DATA

Information concerning the pertinent data used in the preparation of this study can be obtained by contacting the Natural and Technological Hazards Division, FEMA, Presidio of San Francisco, Building 105, San Francisco, California 94129.

9.0 BIBLIOGRAPHY AND REFERENCES

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2. Sellers and Hill, Editors, Arizona Climate, Tucson, Arizona: University of Arizona Press, 1973

3. Mohave County Planning and Zoning, Draft Report, Mohave Valley North Area Plan, November 1979

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6. U.S. Department of Agriculture, Soil Conservation Service, General Soil Map and Interpretations, Mohave County, Arizona, January 1974

7. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Atlas 2, Precipitation-Frequency Atlas of the Western United States, Volume VIII - Arizona, J.F. Miller, R.H. Frederick, R.J. Tracey, 1973

8. U.S. Department of Housing and Urban Development, Federal Insurance Administration, Flood Hazard Boundary Map, Mohave County, Arizona, Scale 1:24,000, February 6, 1979

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Exhibit 2 - Elevation Reference Marks

REFERENCE MARK	FIRM PANEL	ELEVATION (FEET NGVD)	DESCRIPTION OF LOCATION
RM1	0015	553.03	A 3-inch brass cap stamped "4SBR 553," 4,050 feet west and 100 feet north of southeast corner of Section 31, T21N, R21W, near southeast corner of Bullhead City post office. Established by U.S. Geological Survey.
RM2	0015	539.74	U.S. Geological Survey 3-inch brass cap, stamped "3 EAM 1965," 1,850 feet west and 900 feet north of southeast corner of Section 1, T20N, R22W, 30 feet west of State Highway 95 centerline and 300 feet north of 2nd Street centerline.
RM3	0015	535.67	U.S. Geological Survey 3-inch brass cap, stamped "4 EAM 1965," 3,000 feet west and 1,500 feet north of southeast corner of Section 12, T20N, R22W, 50 feet southeast of intersection of State Highway 95 and Secret Pass Road.
RM4	0015	535.12	Arizona Department of Transportation brass cap in upstream concrete box culvert headwall of Silver Creek Wash and State Highway 95, 700 feet north and 800 feet west of southeast corner of Section 9, T20N, R22W.
RM5	0015	790.24	A 3-inch brass cap set in large boulder, stamped "6 EAM 1965," 0.9 mile east of State Highway 95, 1,850 feet east of southwest corner of Section 13, T20N, R22W.
RM6	0015	510.87	Chiseled "X" in top head bolt on east side of fire hydrant on southwest corner of River Front Drive and Colorado-Rio Vista, 1,250 feet

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Exhibit 2 - Elevation Reference Marks (Cont'd)

REFERENCE MARK	FIRM PANEL	ELEVATION (FEET NGVD)	DESCRIPTION OF LOCATION
			west and 4,400 feet north of southeast corner of Section 17, T20N, R22W. Established by Mohave County Engineer.
RM7	0015	656.6	U.S. General Land Office pipe and cap stamped "T20N R22W S17 S16 1915," located 890 feet east of intersection of State Highway 95 and Hancock Road at the southwest corner of Section 16, T20N, R22W.